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USE OF ERTS-1 IMAGERY TO INTERPRET WIND-EROSION HAZARD IN THE SANDHILLS OF NEBRASKA 1/

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Within the Sandhills of Nebraska, areas where wind erosion has destroyed the productivity of the rangeland are called "blowouts" or "blown-out land" (8). Interpretations of imagery obtained from the Earth Resources Technology Satellite (ERTS-1) indicate that blowouts in the Sandhills region can be identified and located on the satellite imagery. In addition, it is possible to identify areas where the vegetation cover has been reduced to a point where the sandy soils are particularly susceptible to wind erosion.

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Blowouts are the result of wind erosion on an unstable landscape where the soils are very sandy. These areas erode because the vegetation cover has been destroyed by cattle trailing, livestock concentration, or cultivation. Once the sand begins to erode, the blowout spreads as vegetation is further destroyed through undercutting, sandblasting, or burial. Erosion will continue until the area is restabilized by vegetation.

Thousands of blowouts ranging in size from less than 2.5 to more than 125 acres (1 to more than 50 hectares) exist in the Sandhills. These represent a significant loss of forage-producing land to the rancher, particularly in areas where large numbers of blowouts exist. In addition, areas of severe wind erosion are of concern to organizations such as the Natural Resources Districts, whose interests lie in improving the condition of the soil resources.

The purpose of this study was to determine whether severe wind erosion and wind erosion hazard could be assessed by interpreting reflectance patterns on images produced by ERTS-1. If areas could be located where wind erosion has been severe in the past -- and where it may thus recur in the future -- the entire region could be mapped and the trouble spots highlighted. Such maps could prove valuable to persons interested in maintaining the range in its best possible condition.

The Sandhills, occupying the north central one-third of Nebraska, consist of about 20,000 square miles (52,000 square kilometers) of eolian fine sand blown into dunes that are now stabilized (2). The most extensive soil in the area is Valentine fine

sand (Typic Ustipsamment) that occupies more than 90% of the area. Other soils include Elsmere (Aquic Haplustoll), Gannett (Typic Haplaquoll) and Loup (Typic Haplaquoll) formed in fine sand in the subirrigated valleys, and Dunday (Entic Haplustoll) and Anselmo (Typic Haplustoll) in the dry valleys.

Procedures used

The ERTS-1 multispectral scanner acquires images of the earth's surface in four wave length bands. Two of these, green (MSS band 4) and red (MSS band 5), are in the visible portion of the spectrum; the remaining two (MSS bands 6 and 7) are in the near-infrared portion. Images are acquired at 18-day intervals during each overpass of the satellite. Examination of images acquired during different seasons in each of the wavelength bands indicated MSS band 5 images obtained on May 14 and 15, 1973, (1295-16564 and 1296-17023) were most suitable for identifying blowouts in the Sandhills. Enlargement of these images as positive prints with a scale of 1:250,000 permitted the identification of blowouts as small as 2.5 acres (1 hectare). Consequently, the distribution and frequency of blowouts were determined by direct visual analysis.

Vegetative biomass was estimated during two different seasons by measuring the optical density of images prepared as positive transparencies with a scale of 1:1,000,000, using a Macbeth Transmission Densitometer, Series 100, and comparing the optical density measurements with estimates of vegetative biomass at selected sites in the field. Images acquired in MSS band 5 on

August 17 and 18, 1972, (1025-16554 and 1026-17012) as well as those obtained on May 14 and 15, 1973, were used in making these interpretations.

Results and discussion

Blowouts are easily recognized on ERTS-1 images in MSS band 5 obtained during May 1973. A major concentration of blowouts within the Sandhills occurs between the Dismal and Middle Loup rivers (fig. 1) in Hooker County, Nebraska (5). The blowouts within this area are located not on the sparsely vegetated "choppy" dunes, as might be expected, but rather within the Valentine-Anselmo soil association (3). Here topography is relatively gentle (fig. 2) and vegetation is relatively dense up to the margins of the blowouts. The cause of the large number of blowouts in this area where vegetation is generally dense is a matter of speculation, but some evidence suggests that the blowouts were the direct result of attempts by early settlers to cultivate the land.

Passage of the Kinkaid Act in 1904 allowed settlers to claim a full section -- 640 acres (256 hectares) -- in the Sandhills. By that time most of the valleys had already been claimed through the Forest Lieu Act of 1897 (4). The remaining uplands were homesteaded and cultivated by the "Kinkaiders." Because of the droughty soil, most homesteaders did not last the required five years but abandoned the land to larger ranchers from whom they had borrowed money. The cultivated fields, left bare when the homesteaders abandoned the land, were susceptible to wind erosion

and the formation of blowouts. It is probable that cultivation was once fairly extensive in places where blowouts are concentrated today. Although rangeland vegetation has become reestablished in portions of the areas once cultivated, many of the blowouts are locations where rangeland vegetation did not become reestablished during the 65 years since the cultivated fields were abandoned. This distribution of blowouts emphasizes the fragile nature of the Sandhills rangeland and the importance of controlling wind erosion within the region.

To illustrate how areas of severe wind erosion are interpreted from ERTS-1 imagery, the frequencies of blowouts were plotted by township -- 36 square miles (94 square kilometers) -- within the Upper Loup Natural Resources District (fig. 3). The resulting map delineates areas where blowouts are present at rates of 20 or less, 21-35, or 36 or more per township. This map pinpoints problem areas and shows where efforts need to be concentrated to stabilize the rangeland. It would be difficult to construct this map entirely from field observations because of the large area involved and the relatively few roads within the region. Using ERTS-1 imagery, however, the authors were able to complete the map in a few days.

The pinpointing of locations of overgrazed or burned areas (6) with the potential for severe wind erosion is also of considerable importance for the management of rangeland within the Sandhills. The production of a complete field inventory of vegetative biomass of the rangeland within the Sandhills would be difficult and costly. However, optical density measurements of

positive transparencies of ERTS-1 images provided an estimate of such vegetative biomass. Areas with less than 10% vegetation cover are considered to be in immediate danger from wind erosion (7).

Portions of the Upper Loup Natural Resources District where the vegetation was reduced to this level in August 1972 and May 1973 are shown in figure 4. Areas that did not recover to more than 10% vegetative cover by mid-May 1973 are potentially hazardous in terms of wind erosion. Multiseasonal monitoring permitted identification of areas of greatest potential erosion hazard. Fall evaluation of vegetation cover would have indicated a much larger area of potential erosion. Lack of vegetative growth during both the fall and following spring suggested a persistent lack of vegetation cover and high wind-erosion hazard. The reduction of vegetation cover to such low levels may have occurred through fires or through overgrazing. Burzlaff (1) reported that even the Choppy Sandhill range site -- the least productive of three Sandhills range sites he described -- had 62.5% of its ground cover as live vegetation when it was in good to excellent condition. The map shown in figure 3 pinpoints areas where the range is in poor condition and where additional blowouts will probably form if control measures are not applied.

Conclusions

In this study it was possible to interpret ERTS-1 imagery acquired in MSS band 5 (visible red) in May 1973 to assess the distribution and frequency of blowouts within the Sandhills

region. These interpretations were facilitated through the use of positive imagery enlarged to a scale of 1:250,000. In addition, measurement of the optical density of positive transparencies from MSS band 5 with a scale of 1:1,000,000 acquired by ERTS-1 in August 1972 and May 1973 permitted the interpretation of broad levels of vegetative biomass and the identification of areas of potential wind-erosion hazard. Maps showing severe wind erosion and potential wind-erosion hazard are valuable tools for planning management practices to keep Sandhills rangeland in good condition.

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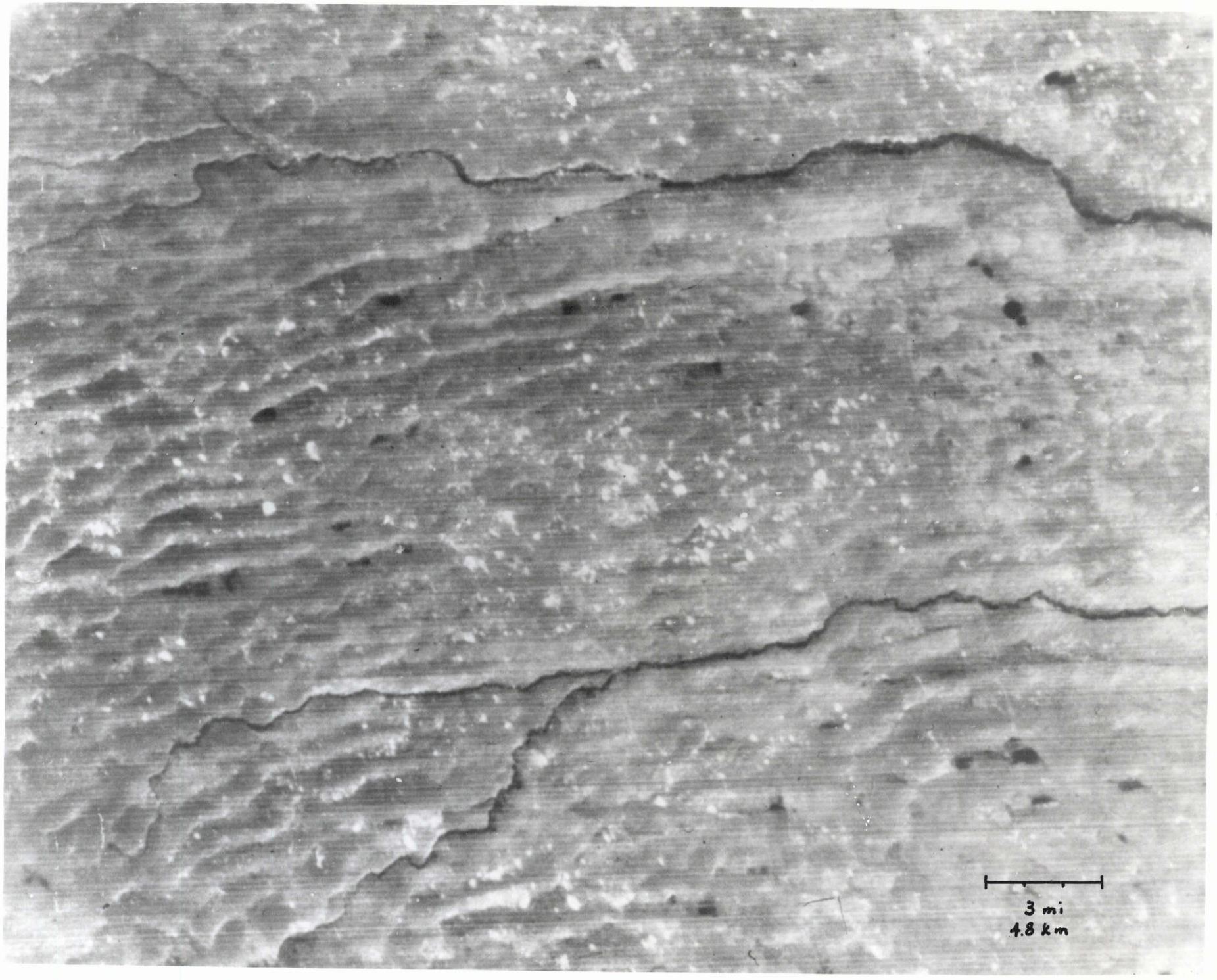
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4.8 km

Figure 1. A portion of an ERTS-1 scene acquired in MSS band 5 on May 14, 1973, showing blowouts in Hooker County in the Sandhills of Nebraska; some of the larger blowouts shown cover 75 acres (30 hectares). The Dismal River (south) and the Middle Loup River (north) are visible on the image. Size relationships can be seen by comparing the size of the blowouts to the dark circular area in the upper right of the image. The dark circular area is irrigated by a center pivot irrigation system and occupies about 135 A (54 hectares).

Figure 2. A view of the area shown in figure 1, just north of the Dismal River. Altitude of the aircraft is 1,000 ft. (300 m).

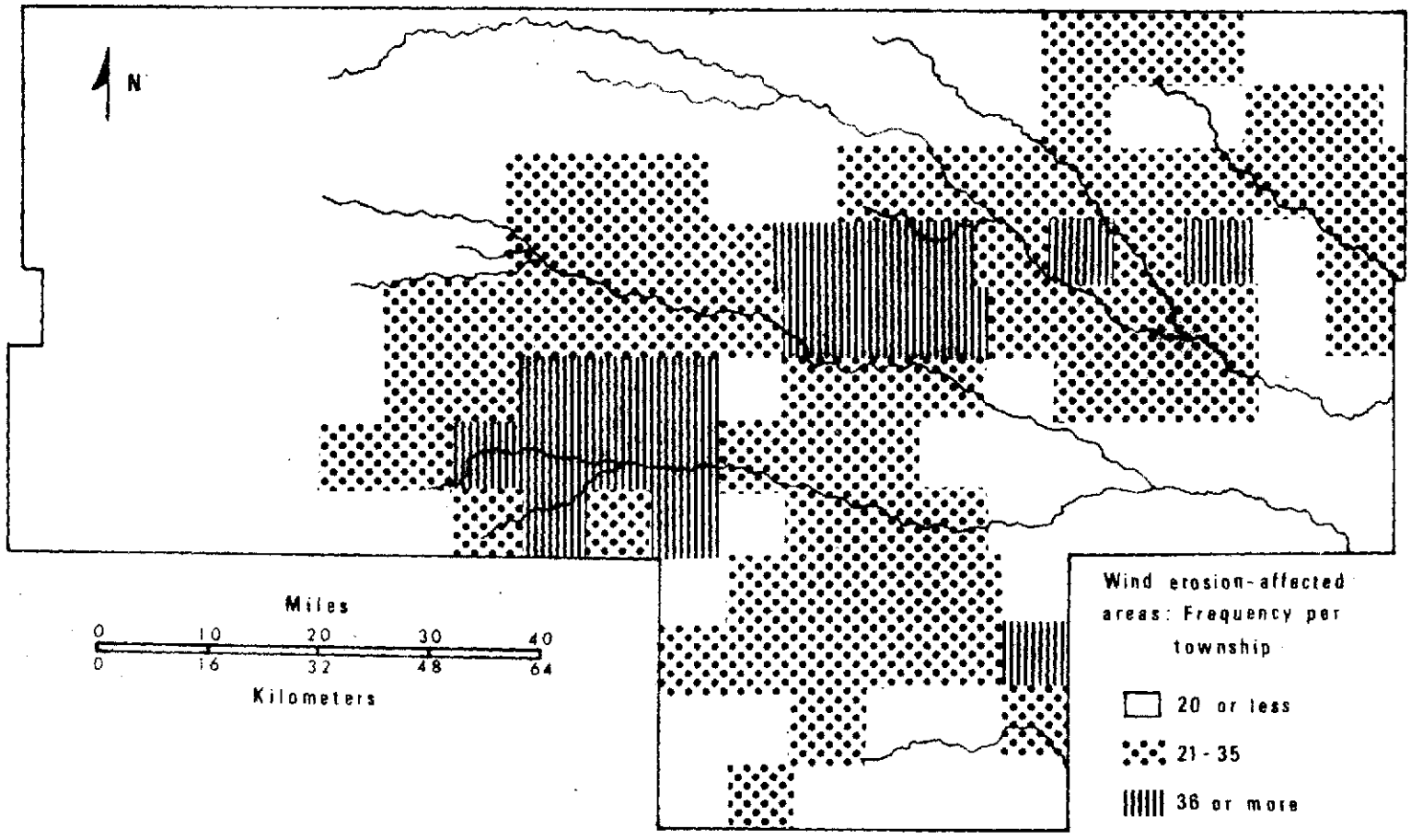

Figure 3

Figure 3. A map showing the location of areas of severe wind erosion in the Upper Loup Natural Resources District in the Sandhills of Nebraska. The blowouts counted were 2.5 to 125 acres (1 to 50 hectares) in size.

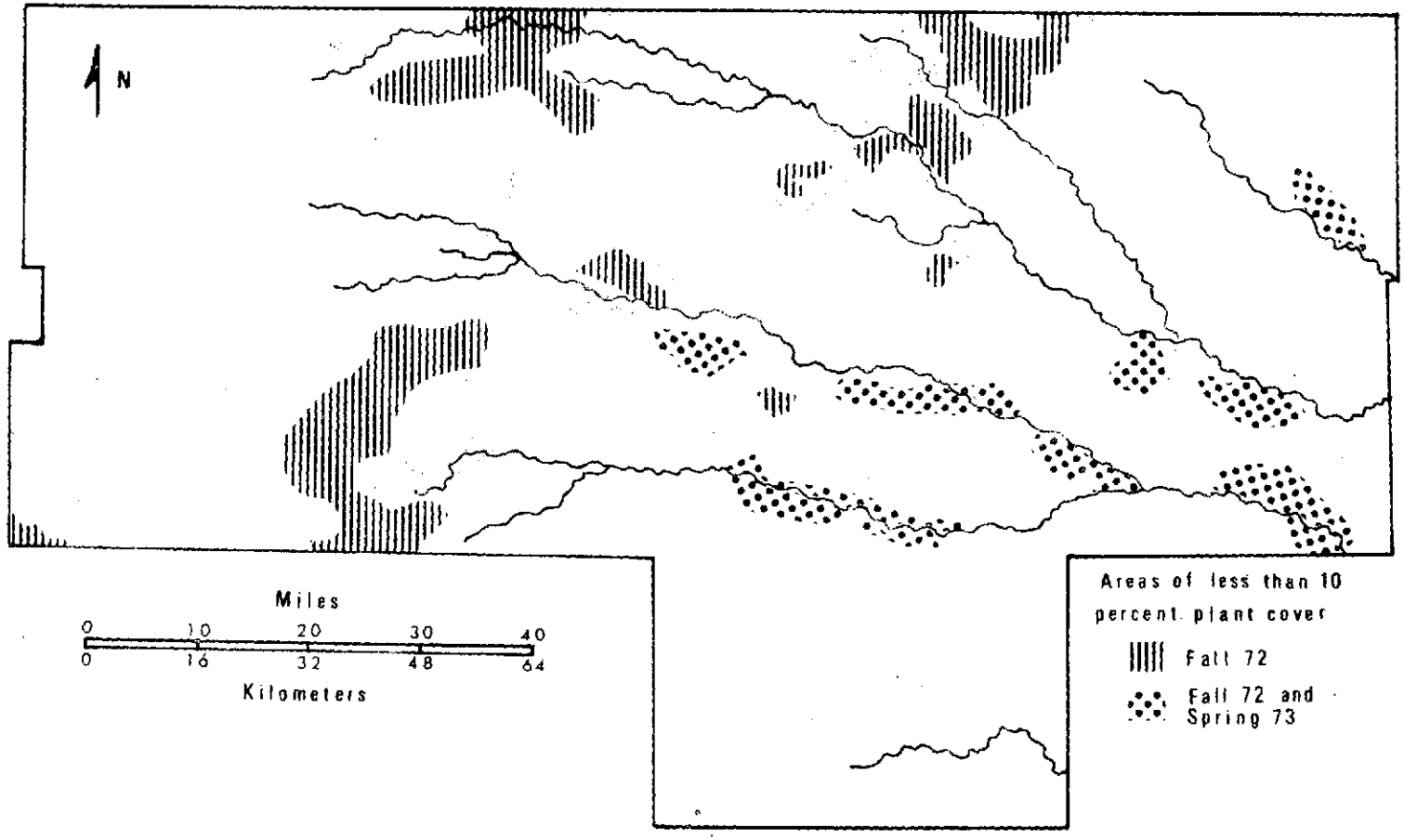

Figure 4

Figure 4. A map showing areas in the Upper Loup Natural Resources District where vegetative biomass is so sparse that wind erosion is apt to occur.

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November 22, 1974

NTIF, NASA Earth Resources Survey
Program Office
P. O. Box 33
College Park, Maryland 20740

Gentlemen:

Re: Proposal to evaluate the use of ERTS-1 imagery in mapping soil and range resources in the Sand Hills region of Nebraska (NASA Contract No. NAS5-21765)

Enclosed is a manuscript dealing with the use of ERTS-1 imagery to interpret wind-erosion hazard in the Sandhills of Nebraska by P. M. Seevers, D. T. Lewis and J. V. Drew. This manuscript has been accepted for publication in the Journal of Soil and Water Conservation.

Before releasing the manuscript, however, we are sending a copy to you for approval from NASA for our publication plans.

Sincerely,

James V. Drew
Dean

JVD:jsw

cc: Mr. G. R. Stonesifer
Mr. John H. Boeckel

Enclosure